Advances in General Surgery With the Hugo™ RAS System: A Monocentric Experience

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This editorial reviews the early experiences and outcomes associated with the application of the Hugo™ Robotic-Assisted Surgery (RAS) system in general surgical procedures, highlighting its technical advantages and clinical implications. A retrospective analysis of three robotic cholecystectomies and three robotic rectal resections performed with the Hugo™ RAS system was conducted, with a focus on operative times, docking efficiency, and patient outcomes. Key system features and procedural strategies were evaluated. Robotic cholecystectomies demonstrated a significant reduction in docking times and excellent patient outcomes, with no complications and short hospital stays. Robotic rectal resections showcased the system's adaptability for intricate pelvic dissections, achieving clear oncological margins and favorable postoperative recovery. The Hugo™ RAS system proves to be a versatile and cost-effective platform for general surgery, with potential to democratize access to robotic-assisted procedures. Future research is warranted to optimize workflows and validate its benefits across broader surgical.

Keywords: robotic surgery; colorectal surgery; Hugo™ RAS system; cholecystectomy; rectal resection

Introduction

Robotic-assisted surgery has emerged as a transformative advancement in minimally invasive procedures, delivering unparalleled precision, improved ergonomics, and enhanced visualization for complex operations. Building upon the success of the Da Vinci platform, new robotic systems have been introduced to overcome its limitations and further refine surgical practices.

The Hugo™ Robotic-Assisted Surgery (RAS) system developed by Medtronic (Version 2.0, Minneapolis, MN, USA©), represents an innovative modular platform designed to offer highly personalized surgical approaches through its four independent robotic arms. Designed as an alternative to existing robotic systems, the Hugo™ RAS system offers a more ergonomic and personalized working environment. Its notable technical advantages include ergonomic trocar placement, increased working space for the bedside assistant, and cost-effectiveness for individual procedures. The platform consists of a console, a system tower, and four independent robotic arm-carts, all engineered to enhance surgical precision and control, allowing for complex procedures with reduced patient trauma, pain, and recovery time.

Key features of the Hugo™ RAS system include exceptional dexterity, an extended range of motion, precise instrument handling, high-definition 3D visualization, haptic feedback, and remote telemetry. Advanced safety features such as collision avoidance, force sensing, and automatic joint lockout further elevate its functionality. Additionally, its modular design supports adaptability across various surgical specialties, including urology, gynecology, colorectal surgery, and general surgery [1].

This editorial seeks to highlight the key features of the Hugo™ RAS system through our single-center experience in general surgery, focusing on its application in procedures such as cholecystectomy, rectal resections.

Expanding the Scope of Robotic Cholecystectomy

Cholecystectomy has long been a cornerstone of general surgery, and the application of robotic platforms has added a layer of precision and adaptability. In our initial experience, three consecutive cases of full robotic cholecystectomy were performed using the Hugo™ RAS system, representing the first reported series worldwide. The innovative design of Hugo™, featuring four independent robotic arms, facilitated optimal trocar placement and minimized instrument collisions (Docking times progressively decreased

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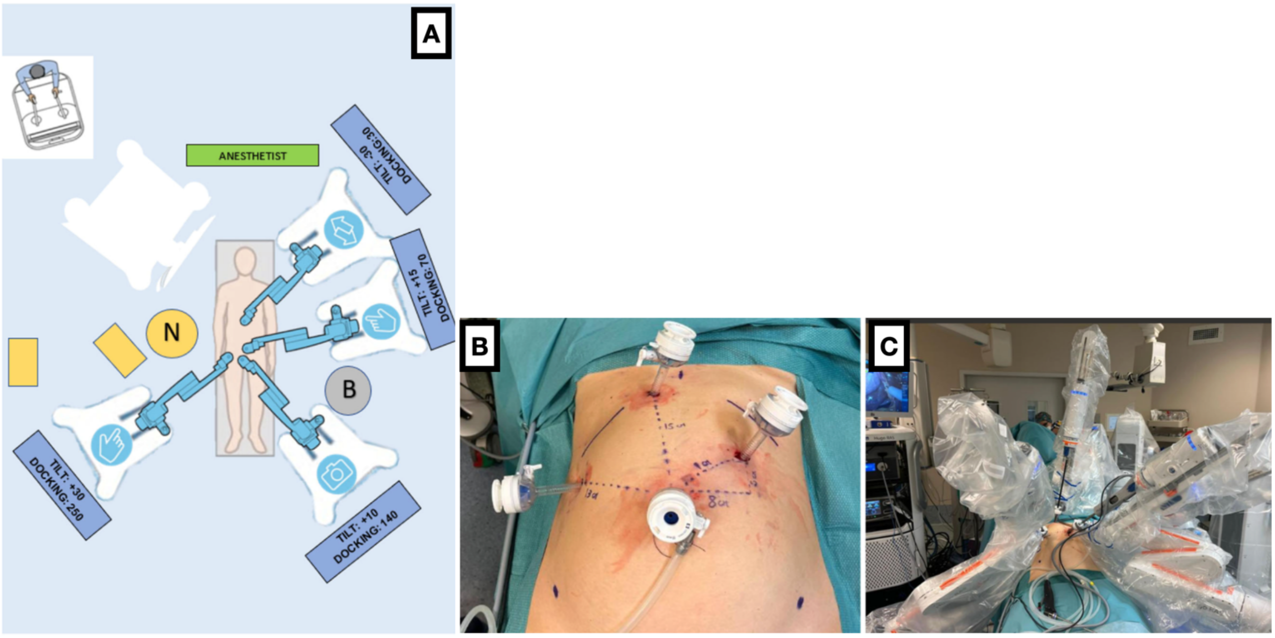

Fig. 1. Hugo Robotic-Assisted Surgery (RAS) set-up for cholecystectomy. (A) The operating room layout for the Hugo™ RAS system setup. Patients are positioned in the American position, with three robotic carts placed on the left and one on the right side of the patient. The central tower is positioned near the patient's head on the right side. The scrub nurse (N) stands on the right, while the bed assistant (B) is positioned on the left. (B) Trocar placement view: the periumbilical port serves as the primary landmark, along with anatomical prominences, to ensure precise positioning of the remaining trocars. (C) Complete docking process of the Hugo™ RAS system, showcasing the robotic arm setup during the procedure. All the figures are self made from our equipe.

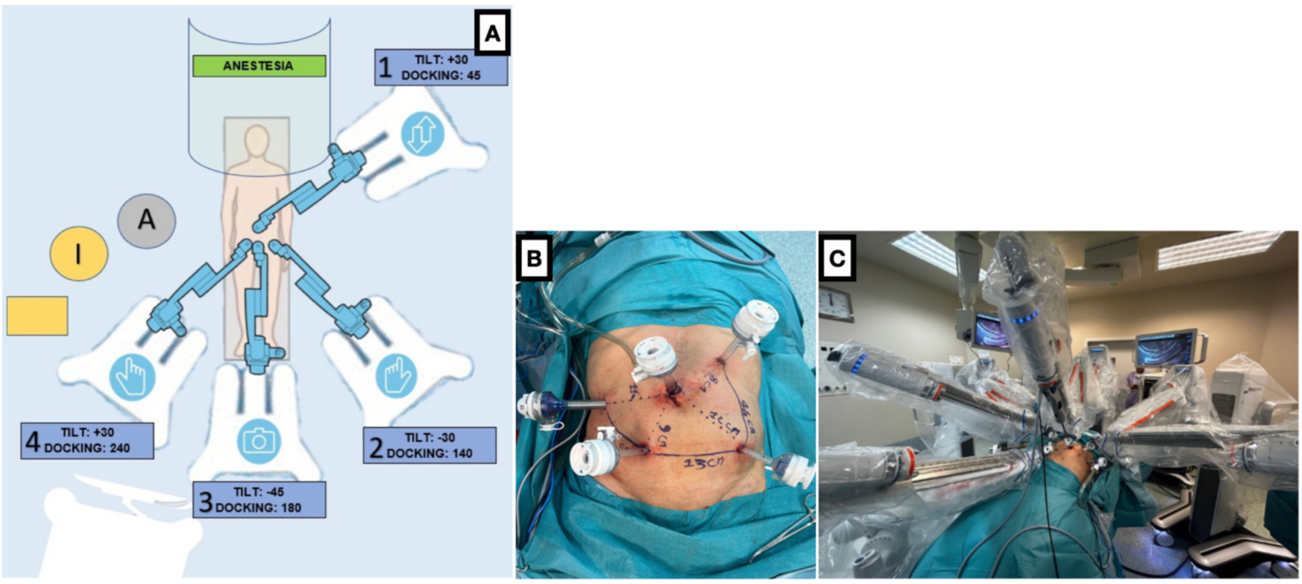

Fig. 2. Hugo RAS set up for low anter anterior resection. (A) Schematic view of the operating room setup for the Hugo™ RAS system. Patients are positioned in the American position. The anesthetist is located at the head of the patient. Robotic arms are configured with three carts positioned on the left side and one on the right. The central tower is located near the head of the patient. The scrub nurse (I) stands on the left side of the patient, while the assistant (A) is positioned on the right. Tilt and docking angles are indicated for each robotic cart. (B) Trocar placement: the periumbilical port serves as the central landmark for positioning other trocars, ensuring precise alignment. (C) Complete docking process: Hugo™ RAS robotic arms fully connected and operational, demonstrating the setup during a clinical procedure. All the figures are self made from our equipe.

from 12 minutes in the first case to 6 minutes in the third, underscoring the learning curve's impact. Operative times ranged from 88 to 105 minutes, with all patients discharged on the second postoperative day and no complications observed [2]. These results are comparable to the original experience of Vicente *et al*. [3]; moreover, we have demonstrated through three preliminary cases that there is a rapid improvement in operative and docking times. The operating room configuration and Hugo™ RAS system setup, along with trocar sites and robotic arms positioning, are illustrated in Fig. 1.

Breakthroughs in Robotic Rectal Surgery

Robotic rectal surgery, especially for cancer, demands precision to achieve oncological clearance while preserving critical structures. Our team's experience with the Hugo™ RAS system included three cases of rectal resection. The initial two cases utilized a hybrid robotic-laparoscopic approach, while the third case marked a full robotic total mesorectal excision (TME). The novel setup we developed eliminated the need for re-docking, reducing operative times and enhancing efficiency. Postoperative outcomes were favorable, with no complications and clear resection margins. These findings highlight the feasibility and potential of Hugo™ in performing intricate pelvic dissections, particularly when coupled with strategic port placement and tailored docking angles [4]. "Our series, the first to be published regarding rectal surgery using the Hugo™ RAS system, has proven effective even when compared to subsequent experiences reported in the literature, further highlighting the potential of the Hugo™ RAS system. Notably, the German study published by Belyaev *et al*. [5], which included 25 colorectal procedures, demonstrated comparable safety and efficacy, despite involving a broader range of operations, such as sigmoid resections, rectal resections, hemicolectomies, and Hartmann's reversals. These findings reinforce the adaptability of the Hugo™ RAS system across various colorectal surgical contexts". The operating room configuration and Hugo™ RAS system setup, specifically designed for robotic rectal resection, along with trocar sites and robotic arms positioning, are illustrated in Fig. 2.

Reflections and Future Directions

Our initial experience with the Hugo™ RAS system across a range of general surgical procedures underscores its versatility and potential as a cost-effective alternative to established robotic platforms. Its modular design has proven to enhance operating room flexibility, allowing for tailored configurations that adapt to different surgical needs. Additionally, the system's reduced cost profile broadens access to robotic technology, offering significant potential for institutions with limited resources. These strengths position the Hugo™ RAS system as a promising tool for expanding the scope of robotic-assisted surgery.

Despite these advantages, challenges remain. The absence of integrated energy devices and staplers currently limits the optimization of procedural workflows and contributes to longer operative times. Addressing these limitations will be crucial to fully realize the system's potential and to ensure its competitiveness with more established robotic platforms. Furthermore, the learning curve associated with a new robotic system, while manageable, requires dedicated training and adjustment by the surgical team to achieve consistent outcomes.

Future research should focus on large-scale, multi-institutional studies to validate these findings across diverse patient populations and a broader range of surgical disciplines, including oncologic and non-oncologic cases. Long-term data on oncological outcomes, functional recovery, and overall patient satisfaction will also be pivotal in assessing the true impact of the Hugo™ RAS system on surgical practice.

Our experience with this novel platform has demonstrated its potential to transform the field of robotic surgery. By combining advanced technological features with cost-efficiency, the Hugo™ RAS system holds the promise of democratizing access to robotic-assisted procedures worldwide. With further refinement, increased adoption, and robust clinical validation, it has the capacity to usher in a new era of minimally invasive surgical innovation.

Conclusions

The Hugo™ RAS system has shown itself to be a transformative tool in robotic surgery. Our experience lays the groundwork for its broader adoption, heralding a new era in minimally invasive surgical innovation. By addressing current limitations and further developing this technology, the system can serve as a viable, cost-effective alternative to existing robotic platforms, providing surgeons with an advanced toolset to enhance patient outcomes.

Availability of Data and Materials

All data generated or analyzed during this study are included in this published article. Additional datasets or materials are available from the corresponding author upon reasonable request, subject to compliance with institutional and ethical regulations.

Author Contributions

DC and RCa designed the research study. RCa, VLV, GM, AC, TF, RCo, and DC performed the research. VLV, GM, and AC collected and analyzed the data. RCa, GM, AC and VLV were involved in drafting the manuscript. All authors (RCa, VLV, GM, AC, TF, RCo, and DC) have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

Damiano Caputo is serving as one of the Editorial Board members of this journal. We declare that Damiano Caputo had no involvement in the peer review of this article and has no access to information regarding its peer review. Other authors declare no conflict of interest.

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